Spatial Statistics - Helsinki University

May – 2010

(24 – hour course)

The statistical analysis and modelling of spatial data is the focus of the course with a strong emphasis on the "hands-on" application of data utilizing the spatial statistical techniques, which are discussed in class. The course will have 24 hours of instructions with two three-hour sessions scheduled each week for four weeks. I plan to use the statistical package ***R*** with the attached graphical users interface ***Rcmdr***, which I have modified to incorporate spatial statistical programs. This course is not a GIS course.

1. Introduction
    - structure of the course
    - types of spatial data
    - analysis & modeling of spatial data
    - basic statistical concepts (a brief review)

Demonstration I (general overview of spatial statistical techniques & software used in the course)
Tutorial I – Getting started

2. Spatial Interpolation
    - methods of interpolation
        - IDW
        - spline functions and GAM
        - TIN models
        - trend surface models

Demonstration II - Interpolation examples
Tutorial II - How surfaces are generated
Exercise I – Visualization and EDA

3. Analyzing geostatistical data – looking for spatial patterns
    - estimating the empirical variogram
    - investigating stationarity
        - median polishing
        - loess trend analysis
        - data transformation
    - problems of anisotrophy
    - fitting theoretical models to the empirical variogram
        - the toolbox of variogram model types
        - assessing the fit - model diagnostics & model verification

Demonstration III - Analyzing data with the variogram
Tutorial session III - Analyzing data with the variogram
Exercise II a&b – a) Examining different interpolation methods; b) Variogram- assessing the spatial relationships and then fitting the model

4. Spatial prediction - methods of Kriging (why Kriging?)

- ordinary Kriging (stationary mean)
    - comparison with other interpolation techniques
- universal Kriging/Kriging with a trend
- block Kriging – change of support
- indicator Kriging – assessing local uncertainty
- types of Kriged output maps
    - predicted surfaces & standard errors of interpolated values
    - quantile maps
    - probability maps
- cross-validation of the Kriging process
- simulating geostatistical data – modeling the spatial uncertainty (both global & local)

Demonstration IV – Kriging examples
Tutorial IV – Getting started on calculating a Kriged surface
Exercise III – What is ordinary Kriging?
Demonstration V – Using indicator and probabilistic Kriging

5. Lattice and areal data
    - neighborhood operations – who are your neighbours and what are they like?
    - spatial autocorrelation tests (Geary/Moran statistic & LISA)

Demonstration V - Checking for spatial autocorrelation
Exercise IV – How close are my neighbours?

6. Spatial Point Process
    - nearest neighbour statistic
    - estimating first and second order point properties
    - simulating point patterns

Demonstration VI - Do the points have a pattern?
Exercise V – Special Project - Solving spatial environmental problems with spatial statistics

7. Putting it altogether
    - building a spatial-statistical model to predict a spatial process
    - course review & discussion – using what we have learned

Within the lectures there will be a series of demonstrations where I will present a discussion of applications and problem solving sessions using the material presented in class. Also there will be four tutorials, which will take the form of in-class sessions or individual work outside of class where the students will work on different spatial data sets. Finally, there will be five take home exercises (work assignments) worth 75% and a final exam worth 25% producing the total for the final grade.
I highly recommended the following textbook for students use:
Bivand, R. S. et. al., 2008: ***Applied Spatial Data Analysis with R***, Springer, NY, 374pp.

John Lewis
12/01/10